



Hazards, Causes and Legal Governance Measures of China's Urban Light Pollution

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ABSTRACT

Urban light pollution, which poses a threat to people's production, life, and physical and mental health, is becoming increasingly serious and gradually forms a new type of environmental pollution. In order to further analyse the hazards and causes of China's urban light pollution and explore its legal governance measures, this study reviews foreign literature on hazards and causes of urban light pollution, summarizes the types and causes of the pollution in China, and provides specific control measures from the perspective of legal governance. Research results in the country and abroad show that light pollution is caused by development, which has a serious negative impact on the normal life of urban residents. The hazards of urban light pollution are manifested in four aspects, such as damaging human health, affecting the natural ecological environment, affecting normal operation of urban traffic, and causing serious waste of energy. Urban light pollution is caused by the lack of systematized urban building light source design work, excessive use of electronic products with the development of science and technology, weak public awareness of environmental protection, and the delay of laws and regulations. Some legal measures to control light pollution are presented as follows: Perfecting the administrative system and environmental supervision system in legislation, innovating the legislation system of light pollution prevention, formulating strict civil liability for light pollution, and further formulating a single law on light pollution control. The results of this study have important reference value for taking measures predictably to avoid the occurrence of light pollution during urban construction design, for the macro-control of urban planning and management departments, and for promoting the concept of urban environmental protection and energy conservation and sustainable urban development.

INTRODUCTION

Light pollution, which includes visible light, ultraviolet, and infrared radiation, is the general term for its negative effects on human health and environment, such as the irradiation, reflection and refraction of glass curtain wall, landscape lighting of buildings or structures, road and traffic lighting, square or site lighting, excessive astigmatism, sky light, glare, reflected light generated by advertising mark lighting and garden landscape lighting, and the negative effects on human health, transportation, astronomical observation, animal and plant growth, and the ecological environment are called light pollution.

Light is an electromagnetic radiation, which human vision can work effectively only in good light conditions. The normal work and life of people will be disturbed because of the glass glare reflection when the sunlight strikes the glass surface of the city building. Strong anti-glare may stimulate the human eye to close, endanger pedestrians and drivers of visual function, and even cause traffic accidents and threaten the lives of people. The urban constructions in

China are advancing by leaps and bounds; urban construction area continues to grow with the rapid development of the national economy. Fig. 1 shows that designers and developers invariably use a large area of mirror-type aluminium alloy decorative exterior wall and glass curtain wall for high quality. Thus, awash specular reflection of sunlight is no longer safe and brings great risks to city life and light pollution. The progress of artificial lighting means great progress and development of human material and spiritual civilization, but it has negative effects on humans because of unrestrained excessive use of artificial lighting in urban areas.

Astronomers proposed that the extension of light pollution has been extended not only at night, since the 1970s, but also during the day. A great deal of research on the causes, present situation, and legal measures of light pollution in the country and abroad has been performed. Garstang analysed the relationship between light pollution, population growth, and air pollution in the Wilson Mountains (Garstang 2000). Longcore believed that the ecological light pollution alters the natural light system of

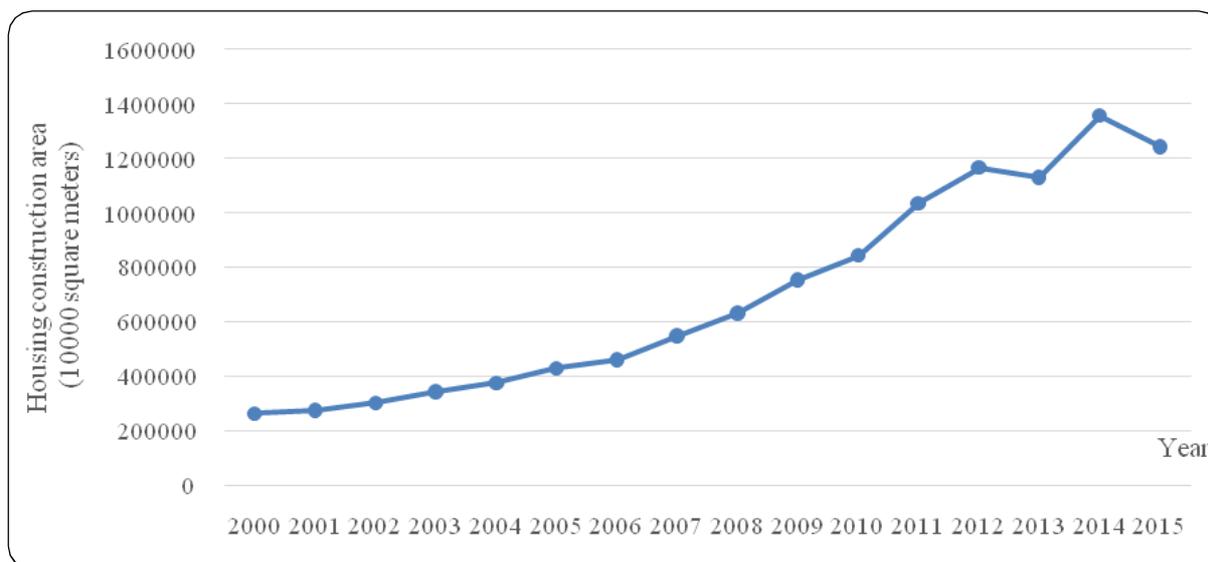


Fig. 1. 2000-2015 China housing construction area.

land and aquatic ecosystems and has a serious effect on living things (Longcore et al. 2006). A modelling analysis was performed for the light pollution in the urban areas of Athens using the geographic information systems (GIS) and remote sensing (RS) techniques. The results show that the level of light pollution in the suburbs of Athens is high and still increasing in the past decade (Chalkias et al. 2006). Horváth believed that the change of natural cycle of artificial light sources has caused harmful effects on animal and ecological systems (Horváth et al. 2009). Hölker analysed the threat of light pollution to biodiversity (Hölker et al. 2010). Cinzano analysed the growth of light pollution in the northeast region of Italy from 1960 to 1995 (Cinzano 2000). Isobe analysed the light pollution energy of different countries, which is monitored through the use of the data obtained by the US DMSP satellite. Energy consumption and light pollution should be reduced (Isobe et al. 2000). Falchi believed that light pollution is the fastest way to deteriorate the environment. Furthermore, the future lighting regulatory restrictions are presented (Falchi et al. 2011). Kyba believed that the skylight caused by artificial lighting in urban areas disturbs natural circulation and affects the behaviour of organisms (Kyba et al. 2011). Aubé believed that light pollution is the result of excessive lighting in the night sky (Aubé et al. 2012). Lyytimäki believed that pollution caused by artificial lighting at night affects global environmental change of the land and coastal and marine ecosystems. Thus, the implementation of strict management measures is reasonable to reduce improper installation or excessive lighting (Lyytimäki 2013). Gaston believed that nocturnal light pollution has a serious effect on the

ecological environment. Artificial lighting changes the natural patterns of space, time, and cross-wavelength light, and affects the structure and function of the ecosystem (Gaston et al. 2013). Bennie conducted a 15-year analysis of European nighttime satellite imagery, which shows that the trend in continental Europe tends to increase brightness, but restrictions can be imposed to reduce the environmental effect of artificial light pollution (Gaston et al. 2013). Pawson stated that the degree and severity of night light pollution on the natural ecosystem is increasing; night light pollution includes LED lighting, which is a major source of increased light pollution (Pawson et al. 2014). Cha summarized the background and main contents of Korean pollution and the current situation of light pollution and presents the corresponding legal measures in this study (Cha et al. 2014). The existing literature shows that the identification of light pollution in the countries all over the world lacks the corresponding legislative and reference environmental standards. Furthermore, light pollution is caused by the progress of times and the highly reflective decorative materials in modern city buildings, such as reflective glass curtain, metal plate, and other external wall decoration. Light pollution cause a serious negative effect on the normal lives of urban residents. This study discusses the current situation of urban light pollution, explores the legal methods of light pollution prevention and control measures by analysing the hazards of urban light pollution, and improvement in the quality of urban light environment.

HAZARDS OF URBAN LIGHT POLLUTION

Serious damage to human health: The strong lighting at

night will disturb the formation of normal human hormones and affect people's health and increase the risk of certain cancers. Inappropriate artificial lighting at night will disturb the body's hormonal levels, thereby affecting the health of the human body. Thus, the incidence of breast cancer in industrialized societies is higher than that in the developing countries. Hormone rhythm will be disturbed if people stay in the light for a long time, causing long-term fatigue, depression, infertility and even cancer. Light pollution also considerably harms people's eyes. The retina of people who keep working or learning in an environment with lighting beyond the national standard of lighting glare will be damaged by different degrees. Their vision will sharply decline, and the risk of developing cataract will increase.

Influence on the natural ecological environment: The effects of urban light pollution on animals and plants, mainly show that night lighting destroys the rhythm of the plant's biological clock, interfere with its growth cycle, and hinder its normal growth. The circadian rhythm of the day and night lives of animals is disturbed, affecting their normal rest. The light pollution caused by urban lighting not only destroys the beautiful night sky, but also wastes many power resources, and the wastes generated by power generation cause serious pollution to the urban environment.

Effect on the normal operation of urban traffic: Night light pollution interferes with the sight of the pilot and has a negative effect on aircraft landing. Interference light produced by outdoor night illumination, especially glare, has a bad effect on the visual performance of car drivers that will reduce the efficiency of their work and even cause traffic accidents to people's normal visual activities. Although traffic is not only complicated in the busiest section of the city, the light pollution caused by unreasonable nightscape lighting easily disperses the driver's attention and causes visual fatigue and even traffic accidents.

Serious energy waste: The city street lights not only illuminate the road, but they also lead to light pollution and wastage of energy. Excessive pursuit of urban lighting not only leads to high energy consumption, but also creates light pollution. With urbanization, many cities have translucent light on buildings at night. Some areas have not yet formed new residential areas. No matter how remote their location, there are no pedestrians on the streets, and the bustling streets of the lighting standard are not inferior to the old city. City night lighting project requires high pre-investment and high power consumption.

CAUSES OF URBAN LIGHT POLLUTION

Lack of systematized urban building light source design work: Some sources of urban light pollution in China are

the reflection of daytime glass curtain wall, excessive use of light and brightly lit advertising screens. Pollution is caused by many factors, such as the lack of an exhaustive, scientific planning and design and inadequate restrictions. Some construction units ignore the quality of the building and ignore possible pollution effects in the future. These units prioritize originality and adopt the use of a highly reflective glass material that covers a huge area for the sake of individuality, luxury and dazzling design style, which eventually lead to the occurrence of pollution damage. Next, the quality of exterior building decoration materials lacks quality standard supervision. To save cost, low quality materials are selected, and serious light pollution ensues. Finally, the defects of design technology result in excessive astigmatism produced by the direct exposure via the ground or the opposite buildings, which poses a risk of traffic accidents.

Development of science and technology requires people the excessive use of electronic products: The use of computers is high because of the popularity of computers and networks, the high amount of information available, and convenience. The traditional way of writing with a pen is gradually disappearing. Copies and materials for work are submitted in electronic document format. Thus, people gradually write on the desk to face the computer screen the whole day. Light stimulation, including that caused by radiation interference, cannot be ignored when people work in front of computer screens for a long time. Dry eyes, dizziness and swelling of the brain are caused by stimulation from light on computer screens. Humans cannot be asked to give up the use of the computer and return to the traditional practice. However, we must remember that the computer and other LCD screens are sources of light pollution, which cause latent health hazards.

Public's weak awareness of environmental protection: The weak public awareness has limited the promotion of environmental awareness for light pollution and light pollution hazard. People lack proper consciousness and fail to maintain their own environmental rights. Light pollution is caused by economic development. The visual enjoyment of people living in the city is also increasing. The belief that show-off high-rise buildings are modern signs and colourful city night is the imprint of the bustling city is a misunderstanding. At present, the discovered or undiscovered light pollution problems in China are mostly caused by poor environmental awareness and lack of light pollution recognition.

Untimely laws and regulations and policy system: Regulating people's behaviour through legislation is an effective way to protect the environment. At present, Chi-

na's environmental legislation system has been basically formed from the relevant departments according to relevant laws and regulations of environmental protection. Therefore, many relevant pollution control and environmental protection systems are gradually established. However, relevant environmental protection laws, that include light pollution, do not exist. The lack of light pollution prevention and control legislation results in the lack of a long-term and effective restraint mechanism for light pollution violations.

LEGAL MEASURES FOR URBAN LIGHT POLLUTION

The administrative system and the environment supervision system in the legislation should be improved: The government plays a significant role in achieving environment-friendly, resource-saving society. The establishment of an effective and efficient administrative system is an important part of light pollution prevention and control work. Therefore, the government should be involved in the administration and formulation of light pollution regulations. The classification of light pollution prevention and control areas based on the type of light source is possible. The area is not the administrative area in the traditional sense. Light source can be divided into incandescent, commercial incandescent, IPL, neon, hydrogen arc welding and white light pollution produced by building materials. The characteristic of light pollution is decentralized. Consequently, the source of light pollution occurs within an administrative region. Thus, light pollution will involve another administrative region because of light scattering and diffusion. Light source management departments can be set up under the management unit, in which each unit is dedicated to a light source for control and management. These departments are not established to divide the existing administrative system as the foundation, but to break the existing traditional administrative division approach. Light pollution has its own characteristics. Its benefits include similar forms of pollution and economic type that can be investigated, evaluated, planned with common techniques and methods. This will greatly simplify the procedure, reduce costs, improve the accuracy of planning conclusions and increase the feasibility and effectiveness of light pollution control.

Innovative light pollution prevention and control legislation system: Artificial light source is the main cause of light pollution. However, artificial light sources are difficult to measure with the same standard and should be managed according to different artificial light sources because they are numerous and varied. A directory system that includes the name of the product, the name of the producer, the function, and the hazard, must be established. The government plays a key role in promoting the prevention and con-

trol of light pollution. Science and technology needs to control light pollution, and the commercial areas that can cause light pollution cannot be separated from the government's leadership and planning. An incentive system must be established to improve the enthusiasm of public participation, which is a kind of social responsibility. However, China has just started with the rule of law society. Social responsibility can be inspired by stimulation and is not suitable for enterprises or individuals who assume the obligation to protect the light environment when the laws and regulations of light pollution are in its start-up stage. The periodical results and environmental quality of light pollution prevention and control will be announced to the public through the media. This method requires the government to maximize the technical information to the public and to establish the corresponding information feedback system. In addition, the government should also use its own resources to maximize the exposure to all kinds of occupied social and technical information and promote the social publicity of light environmental protection information.

Formulate strict civil liability for light pollution: Environmental legal liability refers to the adverse legal consequences of the perpetrator's behaviour when its conduct is illegal, such as breach of contract or special provisions of the law and causes environmental damage. Therefore, special attention should be paid to the formulation of strict legal responsibilities in the legislative process of light pollution prevention. Then, the generation of light pollution must be controlled and supervised effectively, because light pollution is difficult to detect and control compared with other forms of pollution. However, based on the present situation of the legal system in our country, legal measures need to be further improved on the administrative responsibility of light pollution and even the burden of criminal responsibility, focusing on the issue of light pollution civil liability. The legal system should be similar to the legal form of tort law on the formulation of civil liability for light pollution infringement. Compensation, according to the characteristics of the light pollution under the mode of tort law, has three kinds, namely, property damage compensation, personal injury compensation and spiritual damage compensation. Property damage compensation applies to light pollution infringement resulting in property damage to the victim and shall pay compensation for the direct property losses and the indirect losses caused by the light pollution. Personal injury compensation applies to personal health damage, medical expenses, loss of working expenses, and disability benefits arising from personal health damage shall be borne by the light pollution infringement party. If the light pollution causes serious mental damage to the vic-

tim, the victim may request compensation for mental damage. Spiritual damage caused by light pollution infringement can be divided into two kinds. One is the infringement of the victim and his family members' right of personality. For example, the victim's physical harm caused the mental anguish of his family members. The other one is the characteristics of light pollution itself, which can cause the victim's psychological fear, grief, despair and other emotions, thereby resulting in the impairment or loss of mental torture and spiritual benefits.

Further formulate a single law on light pollution control:

The legislation on light pollution prevention and control aims to limit the consumption of resources caused by excessive lighting in China, to build green lighting environment, protect and improve the living and ecological environment, and ensure human health, as well as to promote a comprehensive and coordinated economic and social sustainable development. Light is the most basic environmental factor for human survival, and all life processes, all animals, plants, and microorganisms are inseparable from the atmosphere. The environment and the health of human life are damaged directly or indirectly because of human behaviour. If the ecological environment is contaminated, then the human living environment and ecological imbalance will be directly affected, causing damage to human and biological health and hinder social and economic development. The prevention and control of light pollution should include two aspects, namely, "prevention" and "governance." On the one hand, the prevention of excessive use of light causes harm, while on the other hand, prevention is the governance of light pollution violation. The provisions of the law on the prevention and control of light pollution should be performed based on the "prevention" and "governance" of light pollution. The prevention and treatment of light pollution creates a clean, comfortable living environment and good ecological environment, protect human health, and maintain a healthy and happy life and work of citizens. Light pollution will inevitably cause harm to the environment because of the improper or excessive production of light. Therefore, the legislation on prevention and control of light pollution seeks the coordination of economic development with resources and environment to achieve the goal of promoting economic and social sustainable development.

CONCLUSIONS

Light pollution, which causes great harm to human physiology and mental health, animal and planter production and growth, social life, and production order, is a common environmental problem in many countries. This

study reviews the literature on the hazards and causes of light pollution in cities abroad, summarizes the types of urban light pollution, analyses the different causes of urban light pollution, and finally presents specific control measures from the perspective of legal governance. The manifestation of the city's light pollution hazards causes serious damage to human health, affects the natural ecological environment, and affects the normal operation of urban traffic, thereby resulting in serious wastage of energy. The design of city building, the source's lack of systematic, scientific and technological development, requires people to excessively use electronic products, the weak public awareness of environmental protection, the untimely system of laws and regulations cause the formation of city light pollution. The administrative and environmental regulatory systems in legislation can be improved, the legislation system of light pollution prevention and control can be innovated, strict civil liability for light pollution can be formulated, and legal measures, such as light pollution prevention and control law, can be further developed to control light pollution. The continuous in-depth study on the case of light pollution in developed countries, the development of light pollution standards, the discussion of green energy-saving lighting and energy consumption, the integration of social lighting resources prevention and control, and different economic development level of light pollution standards are suggested.

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